Intracranial Pressure Monitor Placement

Intracranial pressure monitor placement is a critical procedure in the management of patients with traumatic brain injury, subarachnoid hemorrhage, hydrocephalus, and other conditions associated with elevated intracranial pressure.

Common techniques include:

- **Intraparenchymal catheter placement** (via bolt or tunneled system)
- **External ventricular drain (EVD)** insertion for both monitoring and CSF diversion

Clinical Purpose

The goal is to obtain **real-time pressure measurements** within the cranial vault to:

- Guide decisions on sedation, osmotherapy, and surgery
- Detect early signs of intracranial hypertension
- Prevent secondary brain injury

Procedural Challenges

Despite being routine in many centers, the procedure carries risks such as:

- **Hemorrhage**
- **Infection (ventriculitis)**
- **Malposition**
- **CSF leakage or obstruction**

Because of these risks, monitoring procedural performance using **CUSUM analysis** helps ensure ongoing safety and quality, especially in training environments or when introducing new devices.

CUSUM Analysis for Intracranial Pressure Monitor Placement

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Relevance to Surgical Quality and Training

ICP monitor placement is an ideal procedure for performance analysis because:

- It is frequently performed in acute care settings
- Outcomes are clearly defined and typically binary
- Complications can have serious consequences
- Technical precision is critical, especially in EVD placement

Tracking performance through structured methods like CUSUM allows neurosurgical teams to

maintain high standards and identify training needs early.

In current clinical practice the intracranial pressure monitoring (ICP) is measured invasively using an intracranial (ventricular, parenchymal, subdural, or extradural) catheter connected to or integrated with a pressure transducer.

Pressure can be measured almost anywhere in the brain and most studies of ICP dynamics have found that pressure pulsations in the brain are identical irrespective of location [1) 2)].

A prospective, observational study was conducted in 122 patients with TBI ≥13 years old with indications for monitoring who were being treated in neurosurgical intensive care units between January 2009 and December 2012. All enrolled patients required monitoring randomly using an external ventricular drain (EVD) or intraparenchymal fiberoptic monitor (IPM). Patients were placed into 2 groups depending on the type of monitoring device. Clinically relevant outcomes, refractory intracranial hypertension, survival rates, and device-related complications were compared between the 2 groups.

There was a significant between-group difference in the Glasgow Outcome Scale score 6 months after injury, which was the primary outcome. Refractory intracranial hypertension was diagnosed in 44 of 122 patients, and patients monitored using IPM had a higher percentage of refractory intracranial hypertension (51.7% vs. 21.0%, $P < 0.001$). The 1-month survival rate was 90.3% in the EVD group and 76.7% in the IPM group (log-rank test, $P = 0.04$), and patients managed with EVDs had a significantly higher 6-month postinjury survival rate compared with patients treated with IPMs (88.7% vs. 68.3%, log-rank test, $P = 0.006$). There was no statistically significant difference between the groups in device-related complications ($P = 0.448$).

Device selection for ICP monitoring provides prognostic discrimination, and use of EVDs may have a bigger advantage in controlling refractory intracranial hypertension. Based on our findings, we recommend routine placement of an EVD in patients with TBI, unless only parenchymal-type monitoring is available [3)].

In a retrospective observational study, manual chart abstraction was used to obtain time-indexed ICP values during a period of 2 years from patients diagnosed with severe traumatic brain injury who had received simultaneous EVD and IPM placement.

When all time points were compared, the correlation between EVD and IPM was strong ($r = 0.6955$). However, when limiting the ICP values to be <20 or <25 in either the EVD or the IPM, the correlation was noted to be weaker ($r = 0.3576$ and $r = 0.4232$, respectively).

There is inadequate evidence to support that intraparenchymal ICP values can be treated in a similar manner to ICP values obtained from an EVD [4)].

Median time to intracranial pressure monitoring is 3 hours in Traumatic brain injury in England and Wales [5].

1)
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